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# *Indian Standard*

# METHODS OF TEST FOR DETERMINATION OF FLAMMABILITY OF SOLID ELECTRICAL INSULATING MATERIALS WHEN EXPOSED TO AN IGNITING SOURCE

## PART 1 HORIZONTAL SPECIMEN METHOD

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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# *Indian Standard*

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## PART 1 HORIZONTAL SPECIMEN METHOD

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# METHODS OF TEST FOR DETERMINATION OF FLAMMABILITY OF SOLID ELECTRICAL INSULATING MATERIALS WHEN EXPOSED TO AN IGNITING SOURCE

## PART 1 HORIZONTAL SPECIMEN METHOD

## 0. FOREWORD

**0.1** This Indian Standard ( Part 1 ) was adopted by the Indian Standards Institution on 25 August 1986, after the draft finalized by the Solid Electrical Insulating Materials Sectional Committee had been approved by the Electrotechnical Division Council.

**0.2** This standard ( Part 1 ) is being brought out as method of test for determination of flammability of solid electrical insulating materials when exposed to an igniting source by using horizontal specimen method.

**0.3** This standard is being brought out into two parts. The other part ( Part 2 ) suggests the flame vertical specimen method of determination of flammability of solid electrical insulating materials when exposed to an igniting source. There are two sources of ignition used in Part 1, that is horizontal specimen method, by incandescent bar and by flame.

**0.4** Since under the methods *BH* and *FH*, different igniting sources are used, the results obtained with these two methods are not equivalent. The vertical position of the test specimen ( method *FV* ) covered in Part 2 of the standard is particularly suitable for evaluating the extent of burning after extinction of the flame. The significant features of these methods of test is the arrangement of the test specimens in either horizontal or vertical position. These testing arrangements make it possible to distinguish between different degrees of flammability of materials. The horizontal position of the test specimens ( method *BH* and *FH* ) is particularly suitable for evaluating the extent of burning and/or the velocity of the flame propagation, that is the burning rate.

**0.5** These methods of test refer to solid electrical insulating materials and are intended to serve as preliminary indication of their behaviour when exposed to an igniting source.

The results make it possible to check the consistency of characteristics of a material and provide an indication of the progress in the development of insulating materials and a relative comparison and classification of various materials.

These methods are designed for quality control and product evaluation. These are not valid for determining the fire hazard of complete items of equipment, since the dimensions of the insulating systems, the design and heat transfer to adjacent metallic parts, etc, greatly influence the flammability of the electrical insulating materials used therein.

**0.6** In the preparation of this standard, assistance has been derived from IEC Pub 707 ( 1981 ) 'Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source', issued by the International Electrotechnical Commission ( IEC ).

**0.7** Classification and methods of test applicable to non-ignitable and self-extinguishing properties of solid electrical insulating materials are covered by IS : 4249-1967*.

**0.8** In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960†.

## 1. SCOPE

**1.1** This standard ( Part 1 ) covers the horizontal specimen method in which the burning rate is evaluated on the basis of extent of burning and/or the velocity of the flame propagation.

The tests are carried out on horizontal position of test specimens of fixed dimensions and under definite assessment criteria with specified igniting sources.

## 2. TERMINOLOGY

**2.0** For the purpose of this standard, the following definitions, in addition to those given in IS : 4249-1967*, shall apply.

**2.1 Flammability** — It is the ability of a material or a product to burn with flame.

**2.2 Incandescent Bar** — It is an igniting source consisting of silicone carbide with metallized contact ends.

*Classification and methods of tests for non-ignitable and self-extinguishing properties of solid electrical insulating materials.

†Rules for rounding off numerical values ( *revised* ).

## 3. PREPARATION OF SPECIMENS

**3.1** The tests are carried out on test specimens of fixed dimensions and under definite assessment criteria with a specified igniting source. The test sepecimens for methods *BH* and *FH* shall be as under:

| | *BH Method* | *FH Method* |
|---|---|---|
| a) Length | 125 ± 5 mm | 125 ± 5 mm |
| b) Width | 10·00 ± 0·20 mm | 13·00 ± 0·30 mm |
| c) Thickness | 4·00 ± 0·20 mm | 3·00 ± 0·20 mm |

**3.2** The test specimens shall be manufactured by compression moulding, transfer moulding, injection moulding, casting, or be machined from sheets, tubes, rods or insulating parts. All edges and faces shall have a smooth finish.

For methods *BH* and *FH*, each test specimen is marked with two lines perpendicular to the longitudinal axis, 25 and 100 mm away from the end which is to be ignited. These marks may be lightly scratched on the surface of the test specimen.

Sets of five test specimens shall be tested.

**3.3** The flammability will usually vary depending on the thickness of the material. Therefore, in addition to the thickness specified, it may be helpful to obtain results for thicknesses of the order of 0·8, 1·6 and 6 mm which are commonly encountered in practice.

## 4. CONDITIONING

**4.1** Before testing, the test specimens shall be conditioned for 48 h at standard atmospheric conditions, that is, at a temperature of 27°C and 60 ± 5 percent relative humidity.

## 5. APPARATUS FOR INCANDESCENT BAR HORIZONTAL SPECIMEN METHOD ( METHOD *BH* )

**5.1 Test Chamber** — Test chamber, draught-free, with capacity of approximately 1 $m^3$ and which permits observation.

For safety and convenience, it is desirable that this enclosure ( which can be completely closed ) be fitted with a device, such as an exhaust fan, to remove products of combustion which may be toxic. However, it is important to note that the device shall be turned off during the actual test and started again immediately after the test to remove the products of combustion.

**5.2 Igniting Source** — An incandescent bar consisting of a silicon carbide rod, 8 mm in diameter, with a usable length of about 100 mm and metallized contact ends.

The incandescent bar shall be capable of being heated to a temperature of 955 ± 15°C by alternating current using a regulating transformer or by direct current using a rheostat. A suitable voltmeter and ammeter or a wattmeter shall be used to adjust the electrical output to about 350 W.

The temperature of the incandescent bar shall be checked either with an optical pyrometer or by depositing on the bar a strip of silver tinsel ( silver content: 99·8 percent ), approximately 0·06 mm thick.

**5.3 Test Unit** — The test unit is shown in Fig. 1 and it includes:

a) A clamp to fix the test specimen with its longitudinal and traverse axes horizontal. The clamp is mounted on the top of an upright holder provided with a sliding base so that specimens of various lengths can be tested;

b) A pivoting metal rod, 8 mm in diameter and 150 mm in length, to locate, before the test, the front end of the clamped specimen in a flatwise position. This rod shall be capable of being rotated into the exact position occupied by the incandescent bar during the test;

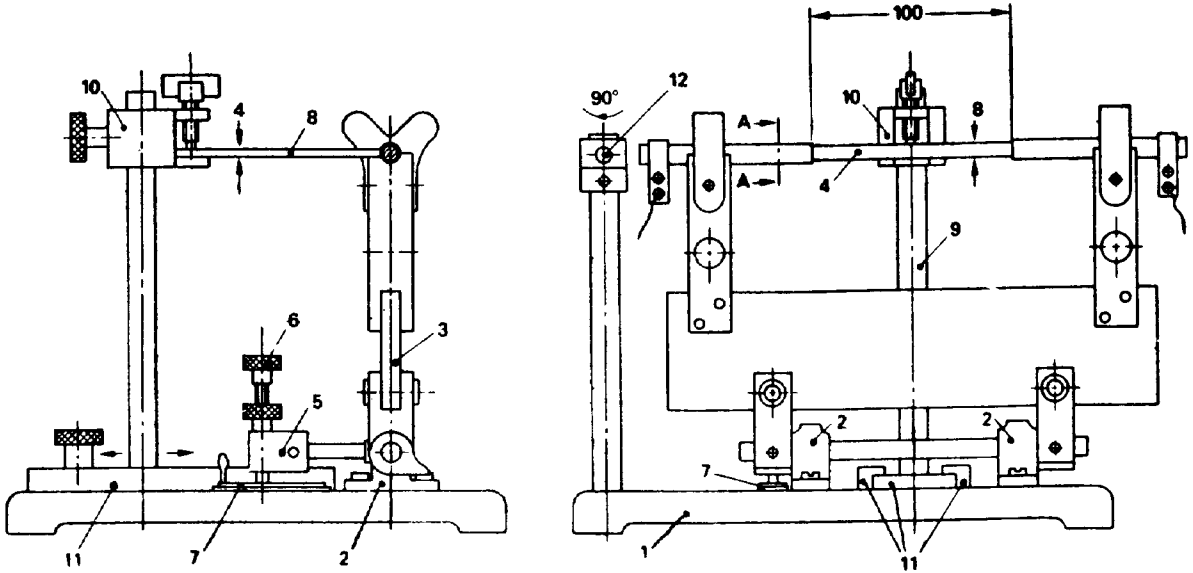
c) An insulated holder ( ceramic or asbestos ) in which the silicon carbide rod is mounted, arranged to rotate about a horizontal axis in two bearings, fixed to the base plate. By this means, the silicon carbide rod may be moved completely away from the test specimen, when necessary. The dimensions of the base plate are 275 × 250 mm approximately;

d) A counterweight dimensioned so that the incandescent bar exerts a force of about 0·3 N on contacting the test specimen; and

e) A stop screw placed by means of a pivoting plate so as to permit the incandescent bar to remain in contact with the test specimen until about 5 mm of the latter has been burnt away.

## 6. PROCEDURE ( FOR METHOD *BH* )

**6.1** Tilt the holder with the incandescent bar down and away from its normal position to permit the metal rod to be turned into the position to be occupied by the incandescent bar during the test. Set up the specimen so that the distance between the clamp and the second mark on the test specimen ( *see* **3** ) is approximately 10 mm. Adjust the clamp and the upright holder to locate the front end of the specimen in contact with the metal rod.




1 = Base plate
2 = Bearings
3 = Holder
4 = Incandescent bar
5 = Counterweight
6 = Stop screw
7 = Pivoting plate
8 = Test specimen
9 = Holder for specimen
10 = Clamp
11 = Sliding base
12 = Pivoting metal rod

FIG. 1 METHOD BH: INCANDESCENT BAR — HORIZONTAL SPECIMEN: TEST UNIT

Heat the incandescent bar to a temperature of 955 ± 15°C in its tilted down position. When the temperature reaches the correct value and remains constant ( that is, when the readings of the ammeter or the wattmeter become constant ), turn the metal rod back to its original position and tilt the holder up so that the incandescent bar comes into contact with the front end of the specimen.

After 3 min, remove the incandescent bar from the specimen by rotating the holder. Observe the behaviour of the specimen and determine the burning time in seconds, using a stop-watch, from the instant when the flame reaches the first mark at 25 mm.

If the specimen does not ignite or if the flame extinguishes, the specimen shall be observed for at least 30 s after the incandescent bar has been removed from the specimen. Any glowing shall be reported. Measure the extent of burning.

If the front of the flame reaches the second mark, stop the test and extinguish the flame.

The burning rate shall be calculated as the distance between the two marks ( 75 mm ) divided by the time for the flame front to travel from the first to the second mark.

**6.2 Evaluation of Results** — The behaviour of the specimen shall be classified in one of the following three categories ( *BH* Incandescent bar — horizontal specimen ):

a) Category *BH* 1 : No visible flame during the test.

b) Category *BH* 2 : The flame ceases to burn before the second mark ( 100 mm ) is reached by the front of the flame. The length of the burnt area shall be added ( for example, *BH* 2-70 mm ).

c) Category *BH* 3 : The front of the flame reaches the second mark ( 100 mm ). The burning rate shall be added ( for example, *BH* 3-80 mm/min ).

**6.3** If all the specimens of a material which are tested, do not have the same numerical classification, the category with the highest number should be reported as the classification for that material.

## 7. APPARATUS FOR FLAME — HORIZONTAL SPECIMEN METHOD ( METHOD *FH* )

**7.1 Igniting Source** — A blue flame, 25 ± 2 mm high, produced from a laboratory burner ( Bunsen or Tirril ) having a tube with a length of 100 mm and an inside diameter of 9·5 ± 0·5 mm. The tube shall not be equipped with end attachments such as stabilizers.

A supply of technical grade methane gas with a suitable regulator and meter to produce a uniform gas flow.

NOTE 1 — If natural gas is used as an alternative to methane, its heat content should be approximately 37 $MJ/m^3$, which has been found to provide similar results.

NOTE 2 — The height of the blue flame with the LPG gas ( of methane origin ) shall be maximum ( varying between 80 and 102 mm ) in the case of Bunsen burners of nozzle diameters lying between 0·98 and 1·1 mm. With petroleum gas on the other hand, the corresponding values should be between 27 and 65 mm.

NOTE 3 — In case of other burners including the Mecker burner and for LPG ( for which the nozzle diameters vary from 1·73 to 2·65 mm ), the flame has a higher percentage of yellow or sooty portion than the blue one and is hence considered unsatisfactory.

NOTE 4 — The extent of blueness of the flame depends on several other factors also like the ratio of volume of air to that of the gas. A ratio of 2·5 : 1 ( air : gas ) is normally recommended to get blue flame.

The blue flame, irrespective of its origin, would give approximately a temperature of 1 100 to 1 200°C, which is much above the degradation temperature of any organic polymer.

It is recommended that by a proper blending of the LPG and compressed air, a complete blue flame could be obtained.

**7.2** A ring stand with adjustable clamps, for horizontal positioning of the specimen and the wire gauge.

**7.3** A wire gauge ( 125 × 125 mm, 20 openings for every 25·4 mm, 0·043 mm diameter steel wire ) shall be clamped horizontally beneath the specimen, with a distance of 10 mm between the lowest edge of the specimen and the gauge, and with the free end of the specimen vertically above the edge of the gauge.

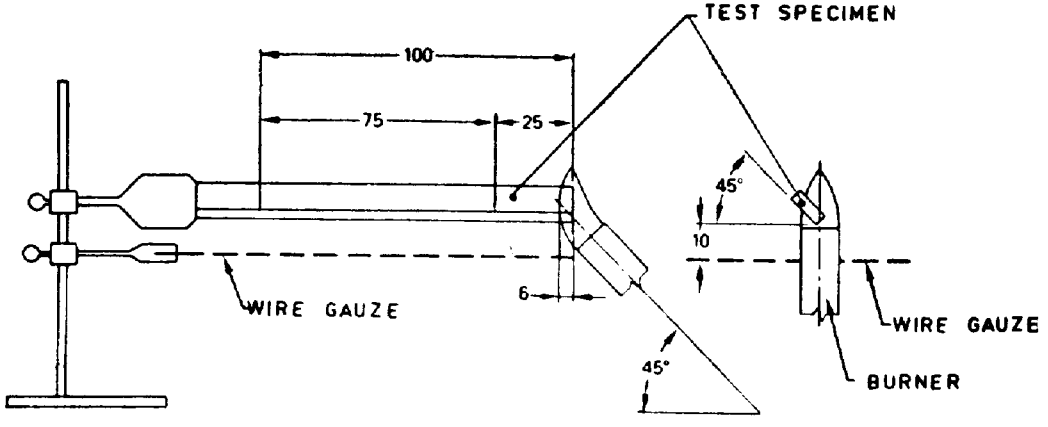
**7.4** A movable holder to maintain the burner tube in the same vertical plane as the lower longitudinal edge of the specimen and at an angle of approximately 45° to the horizontal.

**7.5** The test unit shown in Fig. 2 is described in **7.1** to **7.4**.

**7.6** The test specimen is fixed with its longitudinal axis horizontal and the test traverse axis inclined at 45°.

## 8. PROCEDURE ( FOR METHOD *FH* )

**8.1** The burner is kept at a place remote from the specimen, ignited and adjusted in the vertical position to produce a blue flame 25 ± 2 mm high. The flame is obtained by adjusting the gas supply and the air ports of the burner until a 25 ± 2 mm yellow-tipped blue flame is produced and then the air supply is increased until the yellow tip disappears. The height of the flame is measured again and corrected if necessary.




All dimensions in millimetres.

FIG. 2 METHOD FH: FLAME — HORIZONTAL TEST SPECIMEN: TEST UNIT

The flame is applied to the free end at the lower edge of the specimen so that a length of approximately 6 mm is subjected to the flame. The axis of the burner tube is to be in the same vertical plane as the lower longitudinal edge of the specimen and at an angle of approximately 45° to the horizontal.

Apply the flame for 30 seconds without changing the position of the burner.

If the specimen burns up to the 25 mm mark before the flame has been applied for 30 seconds, the flame application is to be discontinued when the flame reaches the 25 mm mark.

If the specimen continues to burn after application of the flame, the time for the flame front to travel from the first mark ( 25 mm ) to the second mark ( 100 mm ) shall be noted.

The burning rate shall be calculated as the distance between the two marks ( 75 mm ) divided by the time for the flame front to travel from the first to the second mark.

**8.2 Evaluation of Results** — The behaviour of the specimen shall be classified in one of the following three categories ( *FH* = Flame — horizontal specimen ):

a) Category *FH* 1 : No visible flame during the test.

b) Category *FH* 2 : The flame ceases to burn before the 100 mm mark is reached by the front of the flame. The length of the burnt area shall be added ( for example, *FH* 2-70 mm ).

c) Category *FH* 3 : The front of the flame reaches the 100 mm mark. The burning rate shall be added ( for example, *FH* 3-30 mm min ).

NOTE — If all the specimens of a material which are tested do not have the same numerical classification, the category with the highest number should be reported as the classification for this material.

## 9. TEST REPORT ( FOR METHODS *BH* AND *FH* )

**9.1** The test report shall include the following information:

a) Test method used, that is, *BH* or *FH*, and reference to this standard;

b) Complete identification of the tested materials, including type and manufacture;

c) Description of method for the preparation of test specimens;

d) Thickness of the specimens;

e) Category in accordance with **6.2** and **8.2**. The individual results shall be stated;

f) Whether the specimens melt without burning, form burning droplets or show any unusual behaviour;

g) Whether the glowing continues after removal of the igniting source;

h) Description of the smoke developed; and

j) Any deviation from the specified conditions such as gas supply.

## BUREAU OF INDIAN STANDARDS

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